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John J. Obrycki
Iowa State University

Aaron D. Gabriel
Iowa State University

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Biological control of the strawberry leaf roller, Ancylis comptana, in Iowa

Abstract
In recent efforts to increase the diversity and stability of Iowa's agricultural economy, people are focusing considerable attention on expanding commercial strawberry production. However, an integrated pest management (IPM) program has not been developed for midwestern strawberry production.

Keywords
Entomology, Biological and integrated pest control, Fruits and vegetables

Disciplines
Agricultural Science | Agriculture | Entomology | Fruit Science

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Biological control of the strawberry leaf roller, *Ancylis comptana,* in Iowa

Principal investigators
John J. Obrycki
Aaron D. Gabriel
Entomology
Iowa State University

Budget
$17,060 for year one
$14,428 for year two

Background and goals

In recent efforts to increase the diversity and stability of Iowa's agricultural economy, people are focusing considerable attention on expanding commercial strawberry production. However, an integrated pest management (IPM) program has not been developed for midwestern strawberry production.

The strawberry leaf roller, or SLR *(Ancylis comptana),* introduced form Europe in the late 1800s, has sporadically caused severe damage to strawberries in the United States, Most commonly a pest east of the Rocky Mountains, it has been reported as a sporadic pest by Iowa's commercial strawberry growers for the past eight years. The SLR feeds on foliage, which subsequently reduces fruit yield. Larvae consume leaf tissue and fold, or roll, leaflets together along the mid-vein (giving the SLR its name). Although SLR normally consume relatively small amounts of leaf tissue, larval densities during outbreaks can completely defoliate a strawberry plant.

Current control recommendations for this Lepidoptera pest in Iowa call for the application of various insecticides at prebloom, during harvest, and before the end of the season. These recommendations are similar to others throughout the Midwest and Northeast that rely solely on insecticides to manage the SLR. The purpose of this project was to provide a basis for the development of a comprehensive strawberry IPM program that is both effective and environmentally safe. Its goals were to determine the influence of certain mortality factors on the SLR.

The investigators' specific objectives were to

1. develop a predictive model for immature (egg to adult) SLR development based on temperature;
2. determine the effect of selected strawberry cultivars on SLR development and oviposition (egg-laying position);
3. examine seasonal SLR population trends and seasonal percentage parasitization by naturally occurring parasitoids (other insects that feed as larvae on the SLR until their development is complete); and
4. determine the roles of temperature and photoperiod (part of the day during which insects are exposed to light) on dormancy of SLR.

Approach and methods

Objective 1—Temperature-development study: To help understand sporadic SLR population outbreaks and to develop a biological control component for suppression of this pest, the investigators examined how temperature influences the insect's development. Larvae were collected from a commercial strawberry field. Adults reared from these larvae provided the eggs used in the study. The eggs collected from females were kept under six different temperatures ranging from 14° to 34° C (57° to 93° F).

Eggs, larvae, and pupae were checked daily for hatching. Only those individuals completing development were included in the data analysis. The investigators then used the temperature/development relationships represented by these data to construct a degree-day

(DD) model. (A degree-day is one degree of departure, on a single day, above the daily mean temperature from a given base temperature.) The following values were used in the model: egg development took 78 DD at temperatures above 10°; larval development took 254 DD above 9.7° C; pupal development took 100 DD above 10.9° C, and egg to adult development took 431 DD above 10.2° C.

Objective 2—Cultivar acceptance and suitability: This part of the study sought to determine whether a biological basis exists for growers' observations of greater SLR infestations on particular cultivars (and ultimately, whether some cultivars possess resistance to this pest). The investigators selected cultivars for this project on the basis of their commercial use and the range in density of their leaf trichomes (short hairs on leaves). Leaf trichomes affect oviposition of the insects; thus, their variation was considered as a factor that may alter SLR oviposition responses.

The investigators used two commercial cultivars widely grown in the Midwest, a third reported to be heavily infested by SLR in Iowa, and a fourth being examined for production in Iowa. (Wild strawberry was also considered a cultivar for the purpose of the study.) The ovipositional *preference* of SLR females was tested with four combinations of strawberry cultivars.

The ovipositional *nonpreference* behavior of SLR females was determined by exposing six mating pairs to a single strawberry cultivar until the female died. Two-day-old mating pairs randomly assigned to a cultivar were given a new leaf each day. Observers recorded daily the number of eggs deposited and the location of each in relation to locations recorded for the preference tests. They also compared the mean number of eggs deposited per female on each cultivar.

Objective 3—Population intensity and field parasitization: The investigators monitored weekly the population densities (number of individuals per leaf) of the SLR and its natural enemies from 1987 through 1989 (see Figs. 1 and 2), noting also their densities according to season. SLR in 300 rolled leaves taken from strawberry fields in 1987 through 1989 were collected at the pupal stage, and SLR adult and parasitoid emergence were recorded. The investigators also conducted tests in caged plots to determine mortality without parasites.

Objective 4—Dormancy of SLR: Late-stage SLR larvae overwinter in a dormant phase in rolled strawberry leaves that remain in fields as litter. Thus, an understanding of its dormancy is necessary to accurately predict the seasonal activity of these insects.

Overwintering populations were maintained outdoors in protective enclosures and sampled during the late fall and winter. Larvae from these field cages were distributed on leaflets equally among constant temperatures and photoperiods and checked every second day for pupation. To investigate the role of temperatures below freezing in ending the dormancy, the investigators began sampling larvae in the fall before the onset of low field temperatures.

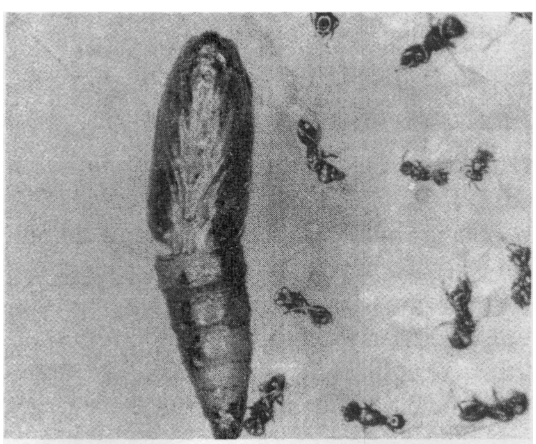

***Fig. 1. (top) Adult parasitoid* Pediobius facialis.**

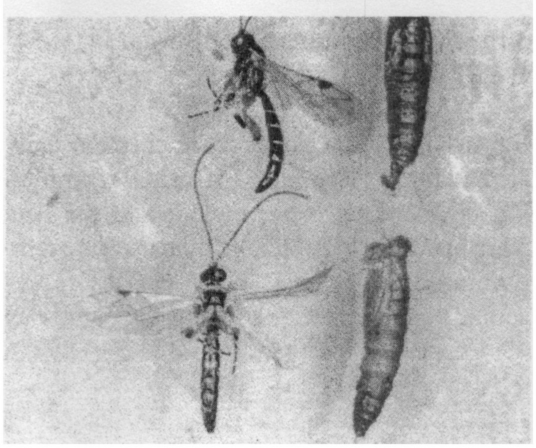

***Fig. 2. (bottom) Adult parasitoid* Itoplectis conquisitor.**

The investigators sampled overwintering larvae in February and March of 1988 to determine the relationship between temperature and spring development. To determine the accuracy of the values to be used for predicting spring development under field conditions, the investigators allowed known numbers of SLR to overwinter in three strawberry plots in 1988 at the ISU Horticultural Research Station at Gilbert.

Findings

Thermal requirements for SLR development: *The model predicted second and third generation egg and larval SLR development stages in the field within three calendar days.* In general, development time increased considerably as temperature decreased. No significant differences appeared between male and female developmental times. While immature temperature/development data alone cannot predict how temperature relates to population growth, this study resulted in an accurate model to predict development of the SLR egg and larval life stages in the field. Immature development of the SLR required 430 DD above 10° C.

Cultivar acceptance and suitability for development: While some trichome characteristics (see Approach and methods) are similar among cultivars used in this study, trichome density was significantly different. In the tests with five cultivars, the number of eggs deposited on two of them was much greater than on the other three. Still, larval and pupal development times and survival did not differ significantly among cultivars. Overall, no consistent pattern of SLR preference or nonpreference behavior was observed among the five cultivars.

Population intensity and field parasitization: Fourteen parasitoid species were identified. The two most abundant species of the 14 parasitoids recovered (/. *conquisitor* and *P. facialis,* both pupal parasitoids) have not been abundant in previous studies of SLR parasitoids in eastern and midwestern states. Weekly sampling data show that the parasitization peaks by these two species were near the SLR pupal peak densities, indicating they are well synchronized with their SLR host.

The survival of SLR in caged plots that excluded parasitoids ranged from 62% to 99%. Mortality in these cages resulted from naturally occurring factors other than parasitoids; however, mortality due to predators or pathogens was not observed.

Dormancy of SLR: During autumn, the role of short daylengths and low temperatures in maintaining dormancy in SLR was shown by the increased developmental times under these conditions. In this study, the larval response of SLR to photoperiod can no longer be observed by the third week of December; that is, the number of days from sampling to pupation are similar under long and short photoperiods.

Field cage studies demonstrated that 50% emergence of adult SLR from overwintering larvae can be predicted accurately when based on the accumulation of approximately 155 DD over 10° C.

Implications

The results of these SLR population studies provide evidence that SLR population dynamics can be examined by analyzing the SLR's seasonal life cycle, including leaf-rolling larvae, pupae, and adults. Because of this insect's leaf rolling behavior, predicting its population development is a critical part of its management. In early stages the insect feeds on unfolded leaves; as larvae mature they fold leaves in half or web them together. These webbed "shelters" may protect the larvae from insecticide even as larvae continue to feed within the webs. This study provided the means to predict egg hatch and larval development to time control measures against larvae before they begin rolling leaves.

Thus, information from this study will help to form the basis of an IPM program for strawberries. Predicting population development using temperature-based models is a particularly important aspect of IPM. *The model developed here accurately predicted SLR development. This means that strawberry growers can use temperature data as a tool for making management decisions.*

For more information contact J. J. Obrycki, Entomology, Iowa State University, Ames, Iowa, 50011, (515)294-8622.

The seasonal development of the SLR is highly synchronized with its strawberry host plant. Accurate predictions of the occurrence of *A. comptana* larvae based on degree-day accumulations can be made on the basis of this study. Management of SLR populations depends on prediction of ocurrence of early insect developmental stages that do not exhibit leaf rolling behaviors. These larval stages are highly susceptible to a range of insecticides, including *Bacillus thuringiensis.* Properly timed *B. thuringiensis* sprays, combined with a persistent level of naturally occurring biotic mortality and a relatively high level of strawberry tolerance for *A. comptana*, provide the foundation for management of this strawberry pest.